University of Kelaniya – Sri Lanka

Centre for Distance and Continuing Education

Faculty of Commerce and Management Studies

Bachelor of Business Management (General) Second Year Examination (External) – 2019

May – 2023

BMGT E2045 – Statistics for Management

No. of Questions: Eight (08)

Time: 03 hours

Answer any **five (05)** questions.

Question No. 01.

a) Define statistic and statistics. **(05 Marks)**

b) List two reasons to study statistics and explain them. **(05 Marks)**

c) List two applications of statistics and explain them. **(05 Marks)**

d) Explain the skills needed by statisticians. **(05 Marks)**

(Total 20 Marks)

Question No. 02.

a) Define the four measurement levels and give an example of each. **(05 Marks)**

b) What is the difference between a parameter and a statistic? **(05 Marks)**

c) Give an example of (i)categorical data, (ii) discrete numerical data, and (ii) continuous numerical data.

(05 Marks)

d) List three methods of random sampling and two methods of non-random sampling. Explain you listed methods.

(05 Marks)

(Total 20 Marks)

Question No. 03.

a) Write down five guidelines that will help you to create the most effective bar charts.

(05 Marks)

b) Find the mean, median, and mode for the following data set.

GPAs (10 students) 1.96, 2.01, 2.25, 2.55, 2.95, 3.02, 3.04, 3.37, 3.51, 3.66

(05 Marks)

c) Sunil and Nimal, two brothers, own fields where they plant cabbages. Sunil plants cabbage by hand, while Nimal uses a machine to control the distance between the cabbages carefully. The diameters of each grower's cabbages are measured. Sunil's cabbages have an average (mean) diameter of 7.10 inches with a standard deviation of 2.75 inches; Nimal's have a mean diameter of 6.85 inches with a standard deviation of 0.60 inches. Nimal claims his method of machine planting is better. Sunil insists it is better to plant by hand.

Explain the above-given scenario using central tendency and dispersion measures of statistics. Use the data to provide a reason to justify **both sides** of the argument.

(10 Marks)

(Total 20 Marks)

Question No. 04.

a) What are the three main approaches to determining probability? Explain the differences among them.

(05 Marks)

b) Given $P(A) = .40$, $P(B) = .50$, and $P(A \cap B) = .05$.

i. Find $P(A \mid B)$

ii. In this problem, are A and B independent? Explain.

(05 Marks)

c) This contingency table describes 200 business management students' major fields. Find each probability and interpret each in words.

Major Field				
Gender	Accounting (A)	Economics (E)	Statistics (S)	Row Total
Female (F)	44	30	24	98
Male (M)	56	30	16	102
Column Total	100	60	40	200

i. P(A)

ii. $P(A \cap M)$

iii. $P(F \cap S)$

iv. P(A/M)

v. P(F/S)

(10 Marks)

(Total 20 Marks)

Question No. 05.

a) On average, 20 percent of the emergency room patients at "Health Guard" Hospital lack health insurance. In a random sample of four patients,

i. What is the probability that two will be uninsured?

ii. What is the probability that fewer than 2 patients have insurance?

(10 Marks)

b) A study found that the mean monthly salaries of employees in a company are normally distributed with a mean of Rs. 160 000 and a standard deviation of Rs. 25 000. Answer the following questions and interpret your answer.

i. What percentage of employees earn less than Rs. 100 000?

ii. What percentage of employees earn between Rs. 100 000 and Rs. 150 000?

iii. What is the minimum salary for the highest paid 5% employees?

(10 Marks)

(Total 20 Marks)

Question No. 06.

A owner of Pizza Hut is concerned about the sales pattern of his product based on its prices and advertising costs. His survey results for 30 weeks are as follows,

(Note that these data are hypothetical data)

You are given the following Excel output, and You are required to answer the given questions based on this output.

Sales (Units)	Price Rs	Advertising cost Rs.	Sales (Units)	Price Rs.	Advertising cost Rs.	Sales (units)	Price Rs.	Advertising cost Rs
35000	250	330	34000	220	350	34000	310	300
46000	150	320	30000	290	320	43000	300	450
35000	300	300	44000	190	350	36000	275	320
43000	200	450	45000	80	150	38000	250	400
35000	288	320	30000	200	270	42500	150	300
38000	250	400	43000	160	400	47000	140	370
43000	150	300	35000	280	330	35000	300	300
47000	140	370	38000	240	400	34000	220	350
45000	200	350	43000	100	310	30000	290	320
49000	150	400	47000	150	370	44000	190	350

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.826344357
R Square	0.682844997
Adjusted R Square	0.659352034
Standard Error	3347.280027
Observations	30

ANOVA

	df	SS	MS	F	Significance F
Regression	2	6.51E+08	3.26E+08	29.06594	1.84998E-07
Residual	27	3.03E+08	11204284		
Total	29	9.54E+08			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	40829.10051	3929.586	10.39018	6.21E-11	32766.25586	48891.95	32766.26	48891.95
price	-67.05839693	9.19349	-7.29412	7.6E-08	-85.9218807	-48.1949	-85.9219	-48.1949
Advertising cost	38.07995751	10.90152	3.493086	0.001663	15.71188201	60.44803	15.71188	60.44803

i. Write the fitted regression equation.

ii. Interpret the estimated coefficients.

iii. What is your conclusion about the slope of the regression equation?

iv. State the degrees of freedom for a two-tailed test

v. Interpret the 95 percent confidence limits for the slope.

vi. What is the interpretation of R^2?

vii. Write a suitable alternative hypothesis for this scenario.

viii. What would be the model predicted for Pizza sales for a week if the price per unit is Rs.500 and the advertising cost is Rs. 450 per week?

ix. How can you confirm the overall significance of the model?

x. In your own words, describe the fit of this regression.

(2 Marks for each)

(Total 20 Marks)

Question No. 07.

a) Explain the Central Limit Theorem.

(05 Marks)

b) A car dealer is taking a customer satisfaction survey. Find the margin of error (i.e., assuming 95% confidence and $\pi = .50$) for (a) 250 respondents.

(05 Marks)

c) A survey of 4,581 Sri Lankans, that owned a mobile phone found that 58 percent are satisfied with the coverage of their cellular phone provider.

   i. Assuming that this was a random sample, construct a 90 percent confidence interval for the true proportion of satisfied Sri Lanka mobile phone owners.

   ii. Why is the confidence interval so narrow?

(10 Marks)

(Total 20 Marks)

Question No. 08.

a) i) List the steps in testing a hypothesis.

   ii) Explain the difference between the null hypothesis and the alternative hypothesis.

   iii) Why do we say "fail to reject H_0" instead of "accept H_0"?

   iv) Define Type I error and Type II error.

   v) Explain the difference between a left-tailed, two-tailed, and right-tailed test.

(10 Marks)

b) A university has found over the years that out of all the students who sat for the exam, the proportion who pass is .70. After a new curriculum and teaching methods, the university wants to check if the proportion of students passing rate has changed significantly. Suppose 1200 students sat for the exam after the curriculum change, and 888 passed. Is there evidence at the $\alpha = .05$ level that the pass rate has changed after revising the curriculum and teaching method ? Justify your answer by using hypothesis testing.

(10 Marks)

(Total 20 Marks)

FORMULAE

Summary Measures

Sample Mean

$$\bar{x} = \frac{x_1 + x_2 + \cdots + x_n}{n} = \frac{\sum x_i}{n}$$

Sample Standard Deviation

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{\sum x_i^2 - n\bar{x}^2}{n-1}}$$

Probability Rules

- **Complement rule**

  $P(A^C) = 1 - P(A)$

- **Addition rule**

  General: $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$

  For independent events:

  $P(A \text{ or } B) = P(A) + P(B) - P(A)P(B)$

  For mutually exclusive events: $P(A \text{ or } B) = P(A) + P(B)$

- **Multiplication rule**

  General: $P(A \text{ and } B) = P(A)P(B \mid A)$

  For independent events: $P(A \text{ and } B) = P(A)P(B)$

  For mutually exclusive events: $P(A \text{ and } B) = 0$

- **Conditional Probability**

  General: $P(A \mid B) = \dfrac{P(A \text{ and } B)}{P(B)}$

  For independent events: $P(A \mid B) = P(A)$

  For mutually exclusive events: $P(A \mid B) = 0$

Discrete Random Variables

Mean

$$E(X) = \mu = \sum x_i p_i = x_1 p_1 + x_2 p_2 + \cdots + x_k p_k$$

Standard Deviation

$$s.d.(X) = \sigma = \sqrt{\sum (x_i - \mu)^2 p_i} = \sqrt{\sum (x_i^2 p_i) - \mu^2}$$

Binomial Random Variables

$$P(X = k) = \binom{n}{k} p^k (1-p)^{n-k}$$

where $\binom{n}{k} = \dfrac{n!}{k!(n-k)!}$

Mean

$$E(X) = \mu_X = np$$

Standard Deviation

$$s.d.(X) = \sigma_X = \sqrt{np(1-p)}$$

Normal Random Variables

- $z\text{-score} = \dfrac{\text{observation} - \text{mean}}{\text{standard deviation}} = \dfrac{x - \mu}{\sigma}$
- Percentile: $x = z\sigma + \mu$
- If X has the $N(\mu, \sigma)$ distribution, then the variable

  $Z = \dfrac{X - \mu}{\sigma}$ has the $N(0,1)$ distribution.

Normal Approximation to the Binomial Distribution

If X has the $B(n, p)$ distribution and the sample size n is large enough (namely $np \geq 10$ and $n(1-p) \geq 10$), then X is approximately $N\left(np, \sqrt{np(1-p)}\right)$.

Sample Proportions

$$\hat{p} = \frac{x}{n}$$

Mean

$$E(\hat{p}) = \mu_{\hat{p}} = p$$

Standard Deviation

$$\text{s.d.}(\hat{p}) = \sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}}$$

Sampling Distribution of $\hat{p}$

If the sample size n is large enough (namely, $np \geq 10$ and $n(1-p) \geq 10$)

then $\hat{p}$ is *approximately* $N\left(p, \sqrt{\dfrac{p(1-p)}{n}}\right)$.

Sample Means

Mean

$$E(\bar{X}) = \mu_{\bar{X}} = \mu$$

Standard Deviation

$$s.d.(\bar{X}) = \sigma_{\bar{X}} = \frac{\sigma}{\sqrt{n}}$$

Sampling Distribution of $\bar{X}$

If X has the $N(\mu, \sigma)$ distribution, then $\bar{X}$ is

$$N(\mu_{\bar{X}}, \sigma_{\bar{X}}) \Leftrightarrow N\left(\mu, \frac{\sigma}{\sqrt{n}}\right).$$

If X follows *any* distribution with mean μ and standard deviation σ and n is large,

then $\bar{X}$ is *approximately* $N\left(\mu, \dfrac{\sigma}{\sqrt{n}}\right)$.

This last result is **Central Limit Theorem**

Population Proportion

Parameter p

Statistic $\hat{p}$

Standard Error

$$\text{s.e.}(\hat{p}) = \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

Confidence Interval

$$\hat{p} \pm z^* \text{s.e.}(\hat{p})$$

Conservative Confidence Interval

$$\hat{p} \pm \frac{z^*}{2\sqrt{n}}$$

Large-Sample z-Test

$$z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$$

Sample Size

$$n = \left(\frac{z^*}{2m}\right)^2$$

Two Population Proportions

Parameter $p_1 - p_2$

Statistic $\hat{p}_1 - \hat{p}_2$

Standard Error

$$\text{s.e.}(\hat{p}_1 - \hat{p}_2) = \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$$

Confidence Interval

$$(\hat{p}_1 - \hat{p}_2) \pm z^* \text{s.e.}(\hat{p}_1 - \hat{p}_2)$$

Large-Sample z-Test

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}(1-\hat{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

where $\hat{p} = \frac{n_1\hat{p}_1 + n_2\hat{p}_2}{n_1 + n_2}$

Population Mean

Parameter μ

Statistic $\bar{x}$

Standard Error

$$\text{s.e.}(\bar{x}) = \frac{s}{\sqrt{n}}$$

Confidence Interval

$\bar{x} \pm t^* \text{s.e.}(\bar{x})$ df $= n - 1$

Paired Confidence Interval

$\bar{d} \pm t^* \text{s.e.}(\bar{d})$ df $= n - 1$

One-Sample t-Test

$t = \frac{\bar{x} - \mu_0}{\text{s.e.}(\bar{x})} = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$ df $= n - 1$

Paired t-Test

$t = \frac{\bar{d} - 0}{\text{s.e.}(\bar{d})} = \frac{\bar{d}}{s_d/\sqrt{n}}$ df $= n - 1$

Two Population Means

General

Parameter $\mu_1 - \mu_2$

Statistic $\bar{x}_1 - \bar{x}_2$

Standard Error

$$\text{s.e.}(\bar{x}_1 - \bar{x}_2) = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

Confidence Interval

$(\bar{x}_1 - \bar{x}_2) \pm t^*(\text{s.e.}(\bar{x}_1 - \bar{x}_2))$ df $= \min(n_1 - 1, n_2 - 1)$

Two-Sample t-Test

$t = \frac{\bar{x}_1 - \bar{x}_2 - 0}{\text{s.e.}(\bar{x}_1 - \bar{x}_2)} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$ df $= \min(n_1 - 1, n_2 - 1)$

Pooled

Parameter $\mu_1 - \mu_2$

Statistic $\bar{x}_1 - \bar{x}_2$

Standard Error

$$\text{pooled s.e.}(\bar{x}_1 - \bar{x}_2) = s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

where $s_p = \sqrt{\frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}$

Confidence Interval

$(\bar{x}_1 - \bar{x}_2) \pm t^*(\text{pooled s.e.}(\bar{x}_1 - \bar{x}_2))$ df $= n_1 + n_2 - 2$

Pooled Two-Sample t-Test

$t = \frac{\bar{x}_1 - \bar{x}_2 - 0}{\text{pooled s.e.}(\bar{x}_1 - \bar{x}_2)} = \frac{\bar{x}_1 - \bar{x}_2}{s_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$ df $= n_1 + n_2 - 2$

One-Way ANOVA

SS Groups = SSG = $\sum_{\text{groups}} n_i(\bar{x}_i - \bar{x})^2$

MS Groups = MSG = $\frac{\text{SSG}}{k-1}$

SS Error = SSE = $\sum_{\text{groups}} (n_i - 1)s_i^2$

MS Error = MSE = $s_p^2 = \frac{\text{SSE}}{N-k}$

SS Total = SSTO = $\sum_{\text{values}} (x_{ij} - \bar{x})^2$

$F = \frac{\text{MS Groups}}{\text{MS Error}}$

Confidence Interval $\bar{x}_i \pm t^* \frac{s_p}{\sqrt{n_i}}$ df $= N - k$

ANOVA Table

Source	SS	DF	MS	F
Groups	SS Groups	$k-1$	MS Groups	F
Error	SS Error	$N-k$	MS Error	
Total	SSTO	$N-1$		

Under H_0, the F statistic follows an $F(k-1, N-k)$ distribution.

Regression

Linear Regression Model

Population Version:

Mean: $\mu_Y(x) = E(Y) = \beta_0 + \beta_1 x$

Individual: $y_i = \beta_0 + \beta_1 x_i + \varepsilon_i$

where ε_i is $N(0, \sigma)$

Sample Version:

Mean: $\hat{y} = b_0 + b_1 x$

Individual: $y_i = b_0 + b_1 x_i + e_i$

Parameter Estimators

$$b_1 = \frac{S_{XY}}{S_{XX}} = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sum (x-\bar{x})^2} = \frac{\sum (x-\bar{x})y}{\sum (x-\bar{x})^2}$$

$$b_0 = \bar{y} - b_1 \bar{x}$$

Residuals

$e = y - \hat{y} =$ observed y − predicted y

Correlation and its square

$$r = \frac{S_{XY}}{\sqrt{S_{XX} S_{YY}}}$$

$$r^2 = \frac{SSTO - SSE}{SSTO} = \frac{SSREG}{SSTO}$$

where $SSTO = S_{YY} = \sum (y - \bar{y})^2$

Estimate of σ

$s = \sqrt{MSE} = \sqrt{\frac{SSE}{n-2}}$ where $SSE = \sum (y - \hat{y})^2 = \sum e^2$

Standard Error of the Sample Slope

$$\text{s.e.}(b_1) = \frac{s}{\sqrt{S_{XX}}} = \frac{s}{\sqrt{\sum (x-\bar{x})^2}}$$

Confidence Interval for β_1

$b_1 \pm t^* \text{s.e.}(b_1)$ df $= n-2$

t-Test for β_1

To test $H_0 : \beta_1 = 0$

$t = \frac{b_1 - 0}{\text{s.e.}(b_1)}$ df $= n-2$

or $F = \frac{MSREG}{MSE}$ df $= 1, n-2$

Confidence Interval for the Mean Response

$\hat{y} \pm t^* \text{s.e.(fit)}$ df $= n-2$

where $\text{s.e.(fit)} = s\sqrt{\frac{1}{n} + \frac{(x-\bar{x})^2}{S_{XX}}}$

Prediction Interval for an Individual Response

$\hat{y} \pm t^* \text{s.e.(pred)}$ df $= n-2$

where $\text{s.e.(pred)} = \sqrt{s^2 + (\text{s.e.(fit)})^2}$

Standard Error of the Sample Intercept

$$\text{s.e.}(b_0) = s\sqrt{\frac{1}{n} + \frac{\bar{x}^2}{S_{XX}}}$$

Confidence Interval for β_0

$b_0 \pm t^* \text{s.e.}(b_0)$ df $= n-2$

t-Test for β_0

To test $H_0 : \beta_0 = 0$

$t = \frac{b_0 - 0}{\text{s.e.}(b_0)}$ df $= n-2$

Chi-Square Tests

Test of Independence & Test of Homogeneity

Expected Count

$$E = \text{expected} = \frac{\text{row total} \times \text{column total}}{\text{total } n}$$

Test Statistic

$$X^2 = \sum \frac{(O-E)^2}{E} = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

df $= (r-1)(c-1)$

Test for Goodness of Fit

Expected Count

$E_i = \text{expected} = np_{i0}$

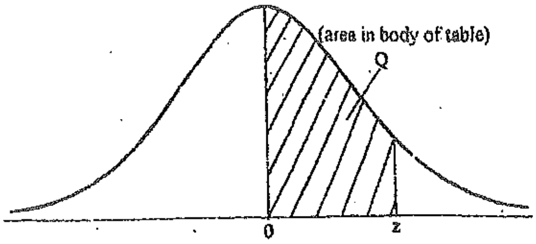
Test Statistic

$$X^2 = \sum \frac{(O-E)^2}{E} = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

df $= k-1$

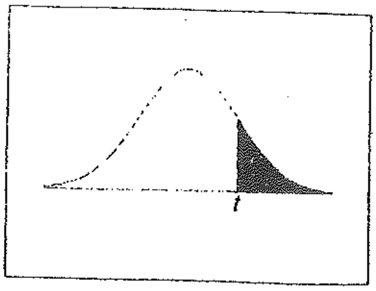
If Y follows a $\chi^2(df)$ distribution, then E(Y) = df and Var(Y) = 2(df).

Table 1 AREAS UNDER THE STANDARD NORMAL CURVE



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

t-Distribution Table



The shaded area is equal to α for $t = t_\alpha$.

df	$t_{.100}$	$t_{.050}$	$t_{.025}$	$t_{.010}$	$t_{.005}$
1	3.078	6.314	12.706	31.821	63.657
2	1.886	2.920	4.303	6.965	9.925
3	1.638	2.353	3.182	4.541	5.841
4	1.533	2.132	2.776	3.747	4.604
5	1.476	2.015	2.571	3.365	4.032
6	1.440	1.943	2.447	3.143	3.707
7	1.415	1.895	2.365	2.998	3.499
8	1.397	1.860	2.306	2.896	3.355
9	1.383	1.833	2.262	2.821	3.250
10	1.372	1.812	2.228	2.764	3.169
11	1.363	1.796	2.201	2.718	3.106
12	1.356	1.782	2.179	2.681	3.055
13	1.350	1.771	2.160	2.650	3.012
14	1.345	1.761	2.145	2.624	2.977
15	1.341	1.753	2.131	2.602	2.947
16	1.337	1.746	2.120	2.583	2.921
17	1.333	1.740	2.110	2.567	2.898
18	1.330	1.734	2.101	2.552	2.878
19	1.328	1.729	2.093	2.539	2.861
20	1.325	1.725	2.086	2.528	2.845
21	1.323	1.721	2.080	2.518	2.831
22	1.321	1.717	2.074	2.508	2.819
23	1.319	1.714	2.069	2.500	2.807
24	1.318	1.711	2.064	2.492	2.797
25	1.316	1.708	2.060	2.485	2.787
26	1.315	1.706	2.056	2.479	2.779
27	1.314	1.703	2.052	2.473	2.771
28	1.313	1.701	2.048	2.467	2.763
29	1.311	1.699	2.045	2.462	2.756
30	1.310	1.697	2.042	2.457	2.750
32	1.309	1.694	2.037	2.449	2.738
34	1.307	1.691	2.032	2.441	2.728
36	1.306	1.688	2.028	2.434	2.719
38	1.304	1.686	2.024	2.429	2.712
∞	1.282	1.645	1.960	2.326	2.576

Gilles Cazelais. Typeset with LaTeX on April 20, 2006.